3.0 EXPOSURE ASSESSMENT

The Phase I ERA protocol (Tetra Tech 2002b) presented the problem formulation, which, as the foundation for an ERA, detailed the exposure setting, the food webs, the assessment endpoints, and the measures of exposures. The protocol also detailed the quantitative methods that were used to calculate COPC EELs for the measurement receptors. This section summarizes the problem formulation and describes the procedures for calculating COPC EELs for each measurement receptor.

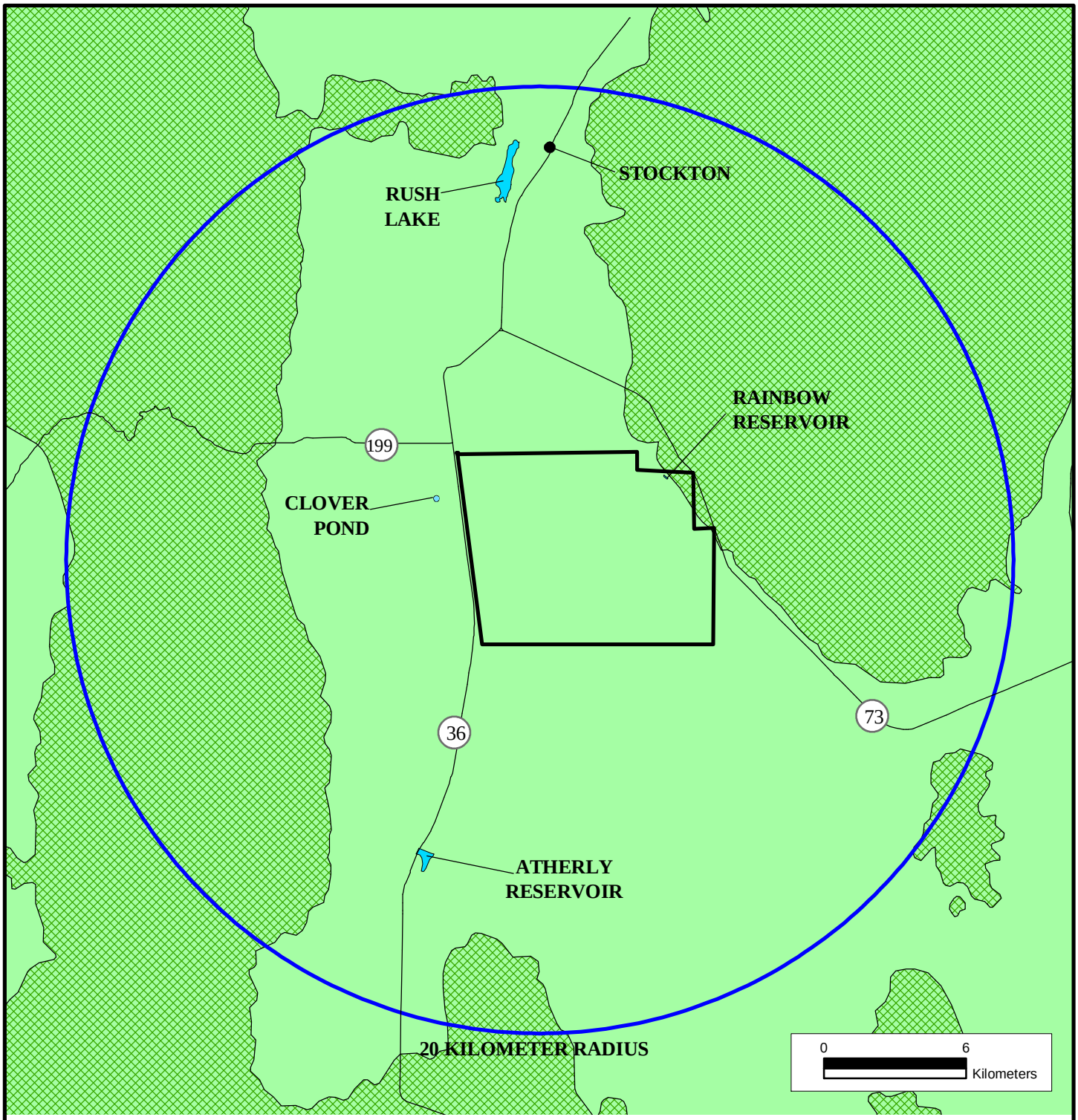
3.1 SUMMARY OF PROBLEM FORMULATION

The problem formulation describes the basis for the ERA and how the assessment will be performed. For a RCRA combustion ERA, the four main aspects of the problem formulation include a description of the exposure setting, the development of food webs to support the direct and indirect exposure assessments, the development of assessment endpoints, and the identification of measures of exposure. The Phase I ERA protocol (Tetra Tech 2002b) detailed each of these aspects of the assessment. Summaries of each of these aspects are presented below.

3.1.1 Exposure Setting

The exposure setting describes ecological characteristics, such as habitats and receptors, which may be impacted by COPCs emitted from the treatment units at DCD. The description of the setting covers a 50-kilometer (km) radius; however, the Phase I ERA focuses on the 20-km radius assessment area covered by the air dispersion modeling. Based on the habitats and receptors in the assessment area, food webs were organized to serve as the exposure models for the indirect (food chain) exposure assessment for vertebrates.

The major habitats in Rush Valley include a salt desert shrub valley floor (shrub-scrub ecosystem), sagebrush-grass benchland (montane ecosystem) east and west of DCD, and several small aquatic ecosystems (Figure 3-1). These habitats are composed of a mosaic of subhabitats, including riparian, intermittent streams, salt shrub, cropland, alkali meadow, chaparral, and grasslands. The aquatic habitats evaluated in the Phase I ERA include Rush Lake, Atherly Reservoir, Clover Pond, and Rainbow Reservoir.



LEGEND

LAND USE CLASSIFICATION

- MONTANE HABITAT
- SHRUB-SCRUB HABITAT
- SURFACE WATER
- DESERET CHEMICAL DEPOT BOUNDARY
- 36 STATE HIGHWAY

N
W E
S

SOURCES: U.S. ENVIRONMENTAL PROTECTION AGENCY, 1977, AND THE STATE OF UTAH DIVISION OF INFORMATION TECHNOLOGY SERVICES AUTOMATED GEOGRAPHIC REFERENCE CENTER, JULY 2000.

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FIGURE 3-1
HABITAT MAP

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Available information about ecological receptors present or potentially present in the shrub-scrub, montane, and aquatic habitats in the assessment area was compiled, evaluated, and organized by habitat and food web. The protocol (Tetra Tech 2002b) presents detailed information about plant and animal receptors in the assessment area. In addition, the protocol lists federal and state special status (threatened, endangered, candidate, and rare) species and special ecological areas in the assessment area.

3.1.2 Food Webs

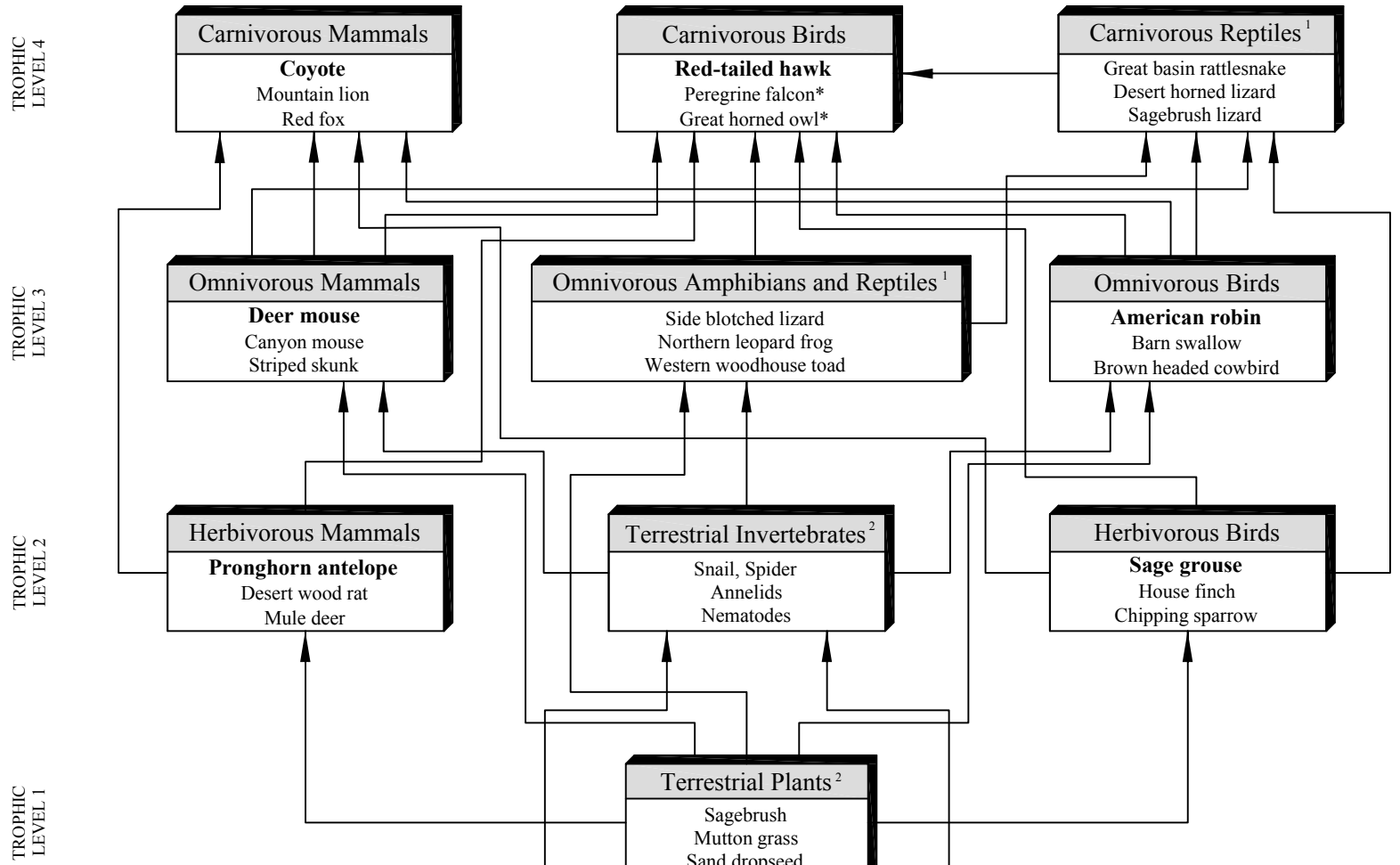
Receptor interactions (e.g., predator–prey) are evaluated to build food webs that are used to estimate indirect exposure by a measurement receptor to a COPC. Plants and animals were categorized according to their habitats and feeding niches, following the example food webs presented in U.S. EPA (1999). The food webs developed for the shrub-scrub, montane, and aquatic habitats are discussed below. The food webs have been organized to be consistent with the mathematical equations provided by U.S. EPA (1999).

For completeness, the descriptions of the food webs mention the amphibians and reptiles expected to be found in the assessment area. However, these receptors are not quantitatively evaluated in a RCRA combustion ERA because information required to model exposure and assess toxicity for these animals is insufficient (U.S. EPA 1999).

Simplified food webs used to facilitate the indirect exposure assessment for mammals and birds were prepared for the shrub-scrub habitat, the montane habitat, and three of the aquatic habitats (Rush Lake, Atherly Reservoir, and Clover Pond) in the assessment area. Note that for Rainbow Reservoir, the fourth water body (that may be stocked with trout), only piscivorous birds were evaluated assuming carnivorous fish are their entire diet. The food webs are presented as Figures 3-2 through 3-4, respectively. The protocol (Tetra Tech 2002b) describes the development of the food webs and the placement of receptors.

3.1.3 Assessment Endpoints

A RCRA combustion ERA uses assessment endpoints to characterize potential ecological risk. Assessment endpoints are explicit expressions of the actual ecological attributes or resources that are to be protected (U.S. EPA 1999). Therefore, their selection represents a scientific and management decision point. An assessment endpoint includes a receptor and one or more attributes relevant to ecosystem structure and function. The assessment endpoints are presented in the protocol (Tetra Tech 2000b).



[1] AMPHIBIANS AND REPTILES NOT QUANTITATIVELY EVALUATED, SO NO MEASUREMENT RECEPTOR SELECTED

[2] COMMUNITY-LEVEL ENDPOINTS ARE EVALUATED FOR INVERTEBRATES AND PLANTS, SO NO SPECIFIC SPECIES IS IDENTIFIED

NOTES:

ARROWS REPRESENT DIRECT CONTACT FOR TERRESTRIAL INVERTEBRATES AND PLANTS, AND INGESTION FOR ANIMALS.

ANIMALS IN BOLD ARE MEASUREMENT RECEPTORS.

* THREATENED OR ENDANGERED SPECIES

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FIGURE 3-2
SHRUB-SCRUB FOOD WEB

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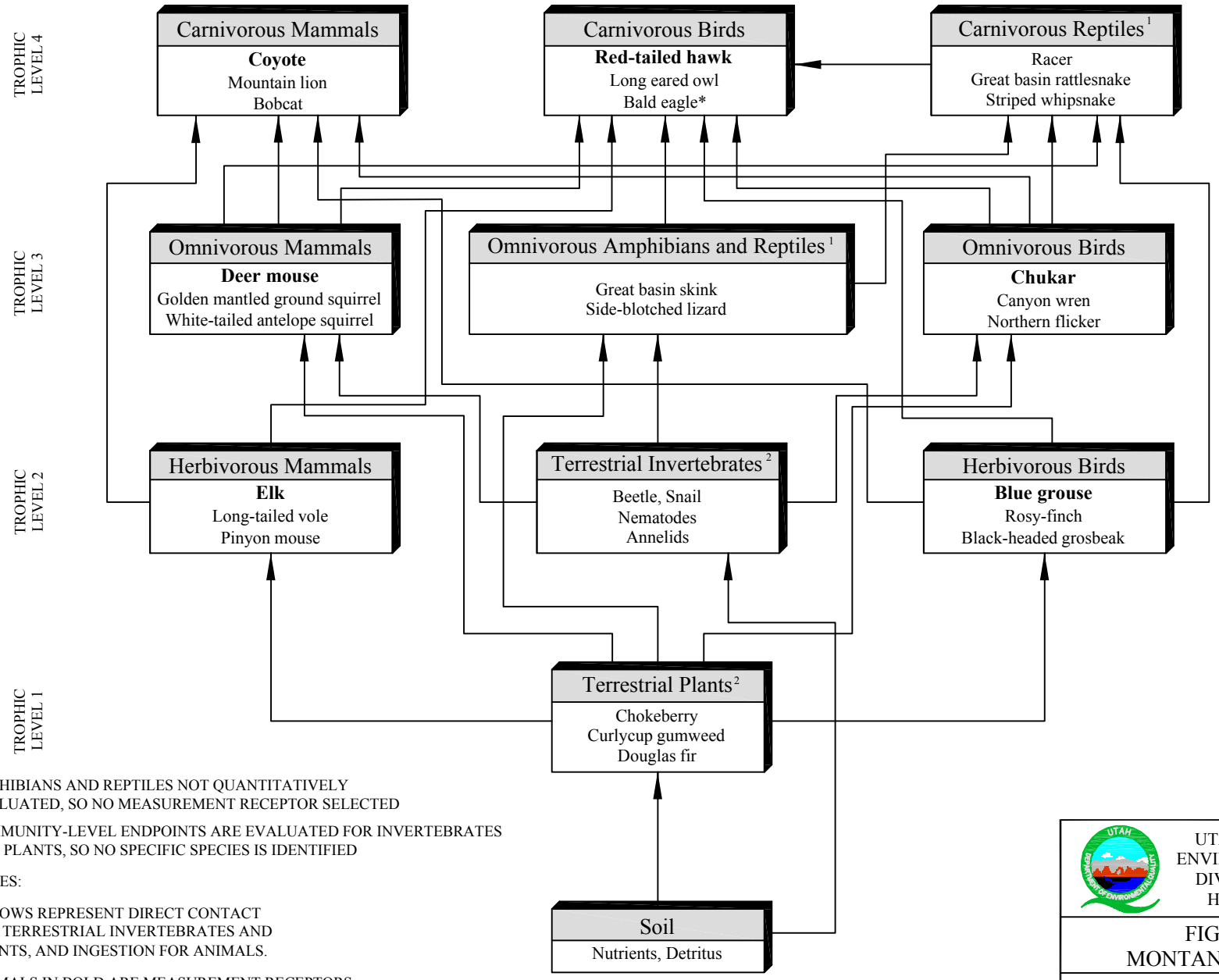

1 AMPHIBIANS AND REPTILES NOT QUANTITATIVELY EVALUATED, SO NO MEASUREMENT RECEPTOR SELECTED

2 COMMUNITY-LEVEL ENDPOINTS ARE EVALUATED FOR INVERTEBRATES AND PLANTS, SO NO SPECIFIC SPECIES IS IDENTIFIED

NOTES:

ARROWS REPRESENT DIRECT CONTACT FOR TERRESTRIAL INVERTEBRATES AND PLANTS, AND INGESTION FOR ANIMALS.

ANIMALS IN BOLD ARE MEASUREMENT RECEPTORS.

* THREATENED OR ENDANGERED SPECIES

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FIGURE 3-3
MONTANE FOOD WEB

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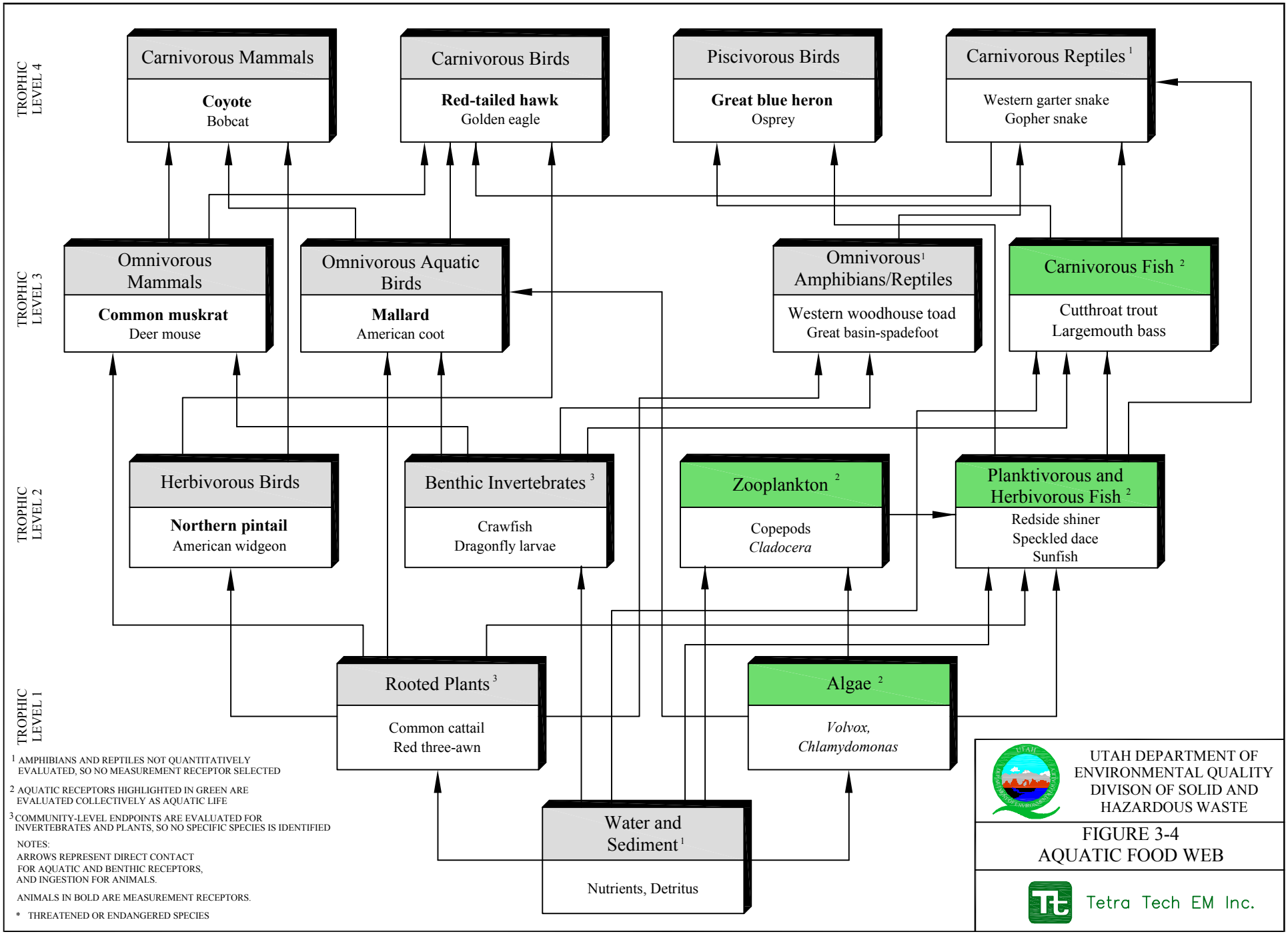

1 AMPHIBIANS AND REPTILES NOT QUANTITATIVELY EVALUATED, SO NO MEASUREMENT RECEPTOR SELECTED

2 AQUATIC RECEPTORS HIGHLIGHTED IN GREEN ARE EVALUATED COLLECTIVELY AS AQUATIC LIFE

3 COMMUNITY-LEVEL ENDPOINTS ARE EVALUATED FOR INVERTEBRATES AND PLANTS, SO NO SPECIFIC SPECIES IS IDENTIFIED

NOTES:
ARROWS REPRESENT DIRECT CONTACT FOR AQUATIC AND BENTHIC RECEPTORS, AND INGESTION FOR ANIMALS.

ANIMALS IN BOLD ARE MEASUREMENT RECEPTORS.

* THREATENED OR ENDANGERED SPECIES

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FIGURE 3-4
AQUATIC FOOD WEB

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3.1.4 Measures of Exposure

Measures of exposure include the identification of exposure scenario locations and measurement receptors (and their attributes) that are used to determine EELs for evaluating exposure for assessment endpoints. The following sections describe the selection of exposure scenario locations and summarize the measurement receptors for each food web evaluated in the Phase I ERA.

3.1.4.1 Identification of Exposure Scenario Locations

Exposure scenario locations are one or more habitat- and water body-specific air dispersion modeling grid nodes for which unitized air concentrations and deposition rates have been determined. EELs for each food web were calculated from air concentrations and depositions for the grid nodes corresponding to each terrestrial (shrub-scrub and montane) habitat and each water body (Rush Lake, Atherly Reservoir, Clover Pond, and Rainbow Reservoir). The highest (among five modeled years) 1-year annual average air concentration and wet and dry deposition rates for each grid node were used to evaluate exposure. To determine EELs for the exposure assessment, these grid node-specific values were averaged based on the assumption that populations of interest are dispersed across habitats and within water bodies. (Note, however, as discussed in Section 4.1.4, that risk isopleths for COPECs presenting ESQ values above the DSHW target level were developed based on air concentrations and depositions specific to each grid.)

To identify exposure scenario locations for each habitat, Microsoft ArcView shapefiles of the site layout, 20-kilometer radius from the centroid of the stacks, and the habitat data were created. Source-specific air concentration and deposition data from the air dispersion modeling plot files were compiled in a Microsoft Access database. The database and the shapefiles were spatially overlaid using GIS software, and the GIS database was queried based on the intersection of the 20-kilometer radius with the two upland habitats (montane and shrub-scrub). The results of these queries were exported back into the Access database where they were queried further in order to find the average habitat-specific air concentration and deposition values for each of the sources. These averages were then manually entered into the air parameters tab of the receptor tool within the EcoRisk View program.

Surface water and sediment concentrations of COPCs specific to each of the four water bodies were determined according to the procedures presented in U.S. EPA (1999). Watershed areas were defined from topographic maps, and the highest 1-year annual average unitized air concentrations and deposition

rates (of the five yearly averages) were used to calculate the COPC concentration in watershed soil for estimating water body loading. The unitized deposition rates corresponding to grid nodes over the area of the water body or those closest to the water body were used to determine the COPC concentration in surface water resulting from direct deposition. The COPC concentration in watershed soil and the COPC concentration in surface water resulting from direct deposition were subsequently used to calculate the total and dissolved COPC concentrations in surface water and the COPC concentration in bed sediment. These concentrations were used in the aquatic food web exposure assessment for each water body.

3.1.4.2 Measurement Receptors for Soil, Surface Water, and Sediment

In accordance with U.S. EPA (1999) recommendations, communities or assemblages of communities were selected as the measurement receptors for plants and animals inhabiting soils, surface waters, and sediments in the assessment area, as follow:

- Soil—Soil invertebrate community and terrestrial plant community
- Surface water—Algae, zooplankton, and fish communities, evaluated as "aquatic life"
- Sediment—Benthic invertebrate community

3.1.4.3 Measurement Receptors for Mammal and Bird Feeding Guilds

A measurement receptor was selected for each guild in each food web to (1) model a COPC dose ingested to mammals and birds and (2) model whole body COPC concentrations in mammal and bird prey ingested by mammalian and avian measurement receptors. The selected measurement receptors ensure that potential risk to other receptors in each guild is not underestimated. Measurement receptors were selected in accordance with U.S. EPA (1999) guidance. The Phase I ERA protocol (Tetra Tech 2002b) discusses the selection of the measurement receptors and the determination of food and media ingestion rates.

3.2 DETERMINATION OF ESTIMATED EXPOSURE LEVELS

The exposure assessment determined COPC EELs for each measurement receptor in each food web. For community measurement receptors, the EEL is the estimated COPC concentration in soil, surface water, or sediment. For mammalian and avian measurement receptors, the EEL is the estimated COPC daily dose. Both "equal" diet and "exclusive" diet exposure assessments were conducted for mammals and

birds evaluated in the Phase I ERA. An equal diet assumes a measurement receptor ingests equal proportions of each food item. An exclusive diet analysis is performed for each food item assuming 100 percent of a receptor's diet is composed of the food item.

3.2.1 Estimated Exposure Levels for Media Communities

The Phase I ERA protocol (Tetra Tech 2002b) presents the equations, fate and transport parameter values, exposure factors, water body characteristics, and assumptions used to determine EELs for media receptors, mammals, and birds. EcoRisk View was executed to quantify the average soil COPC concentration (C_s) for the shrub-scrub habitat, the montane habitat, and the watershed for each aquatic ecosystem. These soil concentrations were used as the COPC EELs for the terrestrial plant and soil invertebrate communities in each habitat or for calculating loading to a water body.

Similarly, EcoRisk View was executed to estimate average COPC concentrations in surface waters and sediments of evaluated water bodies that were used as the EELs for surface water and sediment communities. The dissolved water concentration (C_{dw}) was used as the EEL for aquatic life, which includes communities like the phytoplankton, zooplankton, and fish (but evaluated together as "aquatic life"). C_{dw} is used as the EEL because aquatic toxicity is caused mainly by the interaction of dissolved toxicants with sensitive external tissues (U.S. EPA 1999). The concentration in bed sediment (C_{sed}) was used as the EEL for evaluating exposure for the benthic communities.

3.2.2 Estimated Exposure Levels for Mammals and Birds

The TOCDF Phase I ERA protocol (Tetra Tech 2002b) presents the equations, exposure factors, and assumptions used to determine EELs for mammals and birds, which include exposure through ingestion of media and exposure through ingestion of food. The highest average air concentrations and wet and dry deposition rates from five years of meteorological data, determined with the EcoRisk View software, were used to calculate EELs. The media concentrations used to calculate EELs for mammals and birds include:

- **Direct and Indirect Soil Exposure**. C_s values were based on the highest (among the five years of meteorological data) annual average air concentration and wet and dry deposition rates for each grid node, averaged across each habitat. C_s values, calculated specific to montane and shrub-scrub soils, were used to determine direct and indirect EELs in soil for mammalian and avian measurement receptors in upland habitats. C_s values for watersheds were calculated similarly.

- **Direct Water and Sediment Exposure**. EcoRisk View was used to determine average COPC concentrations in surface waters and sediment of water bodies under evaluation. Total water concentration (C_{wctot}) and C_{sed} estimated for Clover Pond west of DCD was used to quantify the direct uptake of a COPC in water ingested by mammalian and avian measurement receptors in the upland habitats. Clover Pond was selected because it is the closest water body to the emissions sources and the results of the HHRA (Tetra Tech 2002a) indicated the highest depositions of COPCs are north and west of TOCDF and CAMDS. In addition, the majority of surface water at DCD that does not discharge to the ground water or evaporate flows into Clover Pond (Tetra Tech 2000).

- **Indirect Water and Sediment Exposure**. EcoRisk View was used to determine average COPC concentrations in surface waters and sediment of water bodies under evaluation. C_{dw} and C_{sed} specific to each water body were used to assess indirect (food chain) exposure by mammalian and avian measurement receptors in the aquatic food webs for each water body. For example, C_{dw} was used to estimate a COPC concentration in a fish ingested by a piscivorous bird, and C_{sed} was used to estimate a COPC concentration in benthic invertebrates.